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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/833,372	04/12/2001	Michael Wojtowicz	12-1100	3137

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Patent Counsel
TRW Inc.
S&EG Law Department, E2/6051
One Space Park
Redondo Beach, CA 90278

EXAMINER	
BAUMEISTER, BRADLEY W	

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 11/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/833,372	WOJTOWICZ, MICHAEL	
	Examiner	Art Unit	
	B. William Baumeister	2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 August 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-5 and 8-11* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-5 and 8-11* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1, 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Song '944 in view of either one of JP 4-251934 (cited previously, English translation enclosed) or alternatively JP 63-248164 (previously made of record).

a. Song generally discloses a GaN-based HBT (see FIG 3): on a substrate 5 is formed an n+ GaN subcollector 3; an n- GaN collector; a p+ GaN base; a relatively wider bandgap n AlGaN emitter; and contacts formed on the subcollector, base and emitter, respectively. The claims are not anticipated because Song does not disclose an AlGaN/GaN superlattice employed for the base.

b. JP '934, see e.g., FIG. 1B, teaches an InP/InGaAs HBT which includes a wide-bandgap InP emitter; a more narrow-bandgap InGaAs collector; and a base composed of a CHIRPed InP/InGaAs superlattice (the same materials employed for that HBT's emitter and collector, respectively) with an effective bandgap that decreases from the emitter side to the collector side for the purpose of increasing the carrier drift, and therefore decreasing the transfer time, within the base region, thereby increasing the HBT's speed (see e.g., paragraph [0005]).

c. JP '164 teaches an AlGaAs/GaAs HBT which includes a wide-bandgap AlGaAs emitter; a more narrow-bandgap GaAs collector; and a base composed of a CHIRPed

(Al)GaAs superlattice (the same materials employed for that HBT's emitter and collector, respectively) with an effective bandgap that decreases from the emitter side to the collector side for the purpose of increasing the carrier drift, and therefore decreasing the transfer time, within the base region, thereby increasing the HBT's speed (e.g., English Abstract).

d. It would have been obvious to one of ordinary skill in the art at the time of the invention to have employed within Song's (Al)GaN HBT, a CHIRPed superlattice base formed of the same materials employed for that HBT's emitter and collector (i.e., AlGaN and GaN), respectively, as taught by either one of JP '934 or JP '164 for the purpose of producing an electric field that increases the carrier drift, and therefore decreases the carrier transfer time across the base, thereby increasing the speed of Song's (Al)GaN HBT. It would have been further obvious to the skilled artisan to have specifically employed AlGaN and GaN in such a base superlattice because (1) JP '934 and JP '164 each teaches that the base superlattice may be composed of the two particular materials that are employed for the emitter and the collector; (2) Song discloses that AlGaN and GaN, in particular, may be employed for the emitter and collector, respectively; and (3) because using these specific materials in the superlattice would enable good lattice matching between the emitter, base and collector.

3. Claim 5 is rejected--and claims 1, 8 and 9 are alternatively rejected--under 35 U.S.C. 103(a) as being unpatentable over either Song/JP '934 or alternatively Song/JP '164 as applied to the claims above, and further in view of Razeghi '277 (previously made of record in IDS #2).

a. As explained above, JP '934 and JP '164 provides motivation for ***why*** one would have wanted to employ an AlGaN/GaN superlattice in the base region of Song's (Al)GaN HBT. Assuming *arguendo* that Song, JP '934 and JP '164 must be read so narrowly as not sufficiently teaching that one actually ***could*** form a p+doped superlattice of AlGaN/GaN, Razeghi provides further evidence that it was known at the time of the invention by those skilled in the art how to form a p+ AlGaN/GaN superlattice. Thus, it would have been further obvious to form a base superlattice from the specific materials of AlGaN/GaN because these are the materials specifically employed in the various regions of Song, and Razeghi teaches how to form a superlattice using these materials.

b. Regarding claim 5, Song does not disclose what particular materials may be used for the substrate on which the GaN-based HBT is grown. Razeghi teaches that sapphire or SiC may be employed as a substrate for GaN-based devices thereover (col. 3). It would have been obvious to one of ordinary skill in the art at the time of the invention to have employed sapphire or SiC for the substrate as taught by Razeghi because these are the two primary substrate materials used for GaN-based device due to lattice-matching issues.

4. Claims 2-4, 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over the prior art as applied to the claims above, and further in view of Ohta et al. 206.

a. The claims mentioned in the previous paragraphs set forth a superlattice (i.e., a structure having an irregular band gap energy), but do not further require that the AlGaN barriers be graded across the superlattice (i.e., do not require the barrier Al content to

decrease from the emitter towards the collector). As such, the claims previously mentioned read on either Song/JP '934 or alternatively Song JP '164 as explained above because the two Japanese references each teach at least that the CHIRP-graded superlattices may be formed specifically by varying the respective thicknesses of the barriers and wells (i.e., wherein the respective barrier and well compositions remain unchanged, but their successive, respective thicknesses are altered).

b. Claims 2-4, 10 and 11 do set forth the further limitation that the CHIRPed base have graded-composition barriers. Regardless of whether either of JP '934 or JP '164 additionally teach the alternative use of CHIRPed superlattices that are specifically barrier-composition-graded instead of thickness-graded to produce the effective change in the base's bandgap, Ohta teaches that either barrier-thickness-grading or barrier-composition-grading can be employed in CHIRPed superlattices to produce effective band-gap changes in superlattice structures (see e.g., FIGs 14-21). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to have employed barrier-graded CHIRPing as taught by Ohta instead of the thickness-graded CHIRPing in the CHIRPed superlattice HBT taught by Song/JP '934, or alternatively Song/JP '164, because the two CHIRP-grading schemes are functional equivalents, both conventionally known at the time of the invention and because barrier-grading enables the use of constant thickness (i.e., thinner) barrier and well layers, and does not require taking into account the change of each barriers' and wells' respective thicknesses for design calculations.

Response to Arguments

5. Applicant's arguments filed 8/23/04 have been fully considered but are not persuasive.

a. Applicant argues, "it is well-known in the semiconductor art that the properties of one material system are not transferable to other material systems in semiconductor fabrication." (REMARKS, page 5.) However, no evidence has been supplied to support this overly broad assertion. It is well settled law that conclusory arguments made by an applicant's representative do not substitute for evidence. In fact, it was well understood that many properties of, or phenomenon exhibited within, one semiconductor material system are indeed transferable to other material systems in semiconductor fabrication. This fact is evidenced the prior art's showing that heterojunction bipolar transistors can be made from many different semiconductor material systems including GaAs-based systems, InP-based systems and GaN-based systems. Moreover, while different semiconductor systems do possess some distinct differences (for example, differences in band gap, lattice constant, crystalline structure, and carrier mobility), these differences were well understood. It is the existence of these well-understood and predictable differences in respective semiconductor materials that particularly motivated the ordinarily skilled artisan to take structures that were conventionally known (such as superlattice-base HBTs) and form them in different conventionally-known semiconductor material systems depending only upon conventional considerations such as the particular, device, circuit or application desired. Please see MPEP 2143.02 and the cases cited therein for the proposition that obviousness only requires some degree of predictability, but does not require absolute predictability.

b. Applicant argues that the examiner has failed to provide a reference that indicates that the band gap phenomenon for which the examiner is submitting the Japanese patent publications applies to semiconductors using other material systems (REMARKS, page 6). Or restated, "the examiner has failed to provide a reference that shows that the teachings of one material system are applicable to a different material system" (REMARKS, page 8). This argument is not persuasive because the two Japanese references themselves employ respectively different material systems: GaAs-based and InP-lattice-matched systems. The fact that the use of the graded superlattice base produces the same phenomenon in these two different material systems evidences that it would also be produced in other material systems.

c. Applicant argues that Razeghi clearly shows that the AlGaN/GaN superlattice is doped with Mg (page 6, last full sentence). The examiner agrees with this assertion but does not understand its relevance: Mg—being a group II element—was commonly employed in GaN-based III-V semiconductors as a p-type dopant. Thus, applicant's assertion is understood to be an acknowledgement that it was known how to p-dope GaN-based semiconductors. However, the examiner was not aware that this fact was in dispute since every artisan reasonably skilled with GaN knew that Dr. Nakamura of the Nichia Corporation discovered how to p-dope GaN-based semiconductors with Mg in the early 1990s.

d. Applicant also argues that Razeghi does not disclose an HBT much less a GaN-based HBT. The examiner fully agrees. However, Razeghi was not supplied to evidence such a teaching.

e. Applicant argues that the examiner has failed to establish a prima face case of obviousness because the examiner is combining multiple references in support of the rejections without a showing that the motivation for combination was suggested by the reference itself. This argument is not persuasive because Song teaches that GaN-based wide-bandgap-emitter HBTs were known. The Japanese references teach that the use of a graded superlattice base in a wide-bandgap-emitter HBT produces a particular beneficial result, motivating its inclusion also in a GaN-based HBT. And the two Japanese references further teach that this same result or phenomenon occurs in different material systems.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure

a. Schetzina '965. FIG 2 provides further evidence that it was known that AlN/GaN (and therefore AlGaN/GaN) inherently forms a type I heterojunction—just like the GaAs-based and InP-based material systems of the JP references.

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after

the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to B. William Baumeister whose telephone number is (571) 272-1722. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

B.WILLIAM BAUMEISTER
PRIMARY EXAMINER

B. William Baumeister
Primary Examiner
Art Unit 2815

November 4, 2004